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# APPARATUS AND SYSTEM FOR IDENTIFYING INFANT-MOTHER MATCH

## CROSS-REFERENCE TO RELATED APPLICATIONS

The present application claims the benefit of U.S. provisional application number 60/212,432 filed June 16, 2000, the teachings of which are incorporated herein by reference.

## FIELD OF THE INVENTION

This invention relates to a system for verifying that mobile (wireless) components have been delivered to a proper predetermined location. The invention will be described with particular reference to a hospital setting, e.g. to verify that an infant is brought to the appropriate mother, the invention is not so limited, and utilities are contemplated.

## BACKGROUND OF THE INVENTION

Typically, when a pregnant woman arrives at a hospital in anticipation of childbirth, the woman is fitted with an identification band, e.g., a bracelet, which includes pertinent information such as her name, her assigned room, and, perhaps, any relevant medical information. The identification band is typically constructed of a plastic material, or a plastic reinforced or coated paper on which information has been computer printed or hand written.

1 Immediately after an infant is born, the infant too is fitted with an identification  
2 band, e.g., an anklet. The infant's anklet typically contains the same basic information  
3 as the bracelet typically worn by the mother. In the hours, or days, subsequent to birth,  
4 the infant will be transported from various places in the hospital to the mother's room  
5 many times. The trips will be toward such ends as feedings and familiarization.

6 Each time the newborn infant is brought to the mother's room, it must be verified  
7 that the infant has been brought to the proper mother. Verification of the infant/mother  
8 match is typically accomplished by comparing the information on the infant's anklet to  
9 that on the mother's bracelet. Unfortunately, this method of verifying an infant/mother  
10 match suffers from two possible problems. First, in a large hospital, in which the  
11 maternity ward may span several floors or wings that may simultaneously  
12 accommodate a large number of mothers and infants, there is a possibility that two or  
13 more mothers/infants may have similar names resulting in an infant being brought to a  
14 woman that is not its mother. When the problem is realized and corrected, there is  
15 bound to be a degree of emotional stress or trauma, especially during the highly  
16 emotional time surrounding childbirth.

17 The second problem is that, even in smaller hospitals, because verification of an  
18 infant/mother match is typically carried out by a side-by-side comparison of the  
19 mother's bracelet and the infant's anklet, if the wrong infant is brought to a mother the  
20 infant is already in the mother's presence, perhaps even her arms, before the error is  
21 realized. As discussed above, such an occurrence is very likely to result in a great deal

1 of anxiety, and potentially undermine the parents faith in the hospital, therein  
2 provoking even greater anxiety.

3 It is therefore desirable to have a system that overcomes the deficiencies of the  
4 prior art by allowing verification of a mother/infant match that is independent of name,  
5 and will allow for verification before the infant is brought into the mother's presence.  
6

### 7 BRIEF SUMMARY OF THE INVENTION

8 An identification system consistent with the invention includes at least one  
9 transmitter configured to transmit a signal including an associated identification code,  
10 and at least one receiver. The receiver is configured to receive the transmitted signal  
11 and establish a comparison of the identification code with a reference code. The  
12 identification system may be further configured to provide a positive indication if the  
13 identification code matches the reference code, and a negative indication if the code  
14 does not match.

15 An apparatus consistent with the invention to provide an infant-mother match  
16 indication is also provided where the transmitted identification code is associated with  
17 one infant. A method of identifying a mobile component match with a receiver  
18 consistent with the invention includes: transmitting an identification code; receiving the  
19 identification code; and comparing the identification code with a reference code to  
20 establish a comparison indication.  
21

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1 BRIEF DESCRIPTION OF THE DRAWINGS

2 For a better understanding of the present invention, together with other objects,  
3 features and advantages, reference should be made to the following detailed description  
4 which should be read in conjunction with the following figures wherein like numerals  
5 represent like parts:

6 FIG. 1 is a block diagram of an exemplary transmitter-receiver pair consistent  
7 with the present invention;

8 FIG. 2 is an exemplary user interface and indicator for use with a receiver  
9 consistent with the present invention;

10 FIG. 3 is a plan view of an exemplary hallway illustrating locations outside of  
11 associated rooms for a plurality of receivers consistent with the present invention;

12 FIG. 4 is a plan view of a room illustrating locations for mounting receivers  
13 consistent with the present invention inside of a room; and

14 FIG. 5 is a flow chart illustrating the operation of an exemplary system consistent  
15 with the present invention.

16  
17 DETAILED DESCRIPTION

18 According to one aspect of the invention, an identification apparatus and system  
19 verifies that one of a plurality of mobile components has been transported to one of a  
20 plurality of receiver locations. In the interest of clarity, the description and illustrations  
21 herein pertain to an embodiment in which an apparatus and system consistent with the

1 present invention is utilized to verify that an infant has been brought to the appropriate  
2 mother in a hospital setting. However, the inventive concept has many utilities. For  
3 example, the inventive concept may be used in a storage warehouse setting or moving  
4 van to assist movers in sorting and delivering goods to their proper storage room or  
5 destination. It also may be used to verify certain materials are located near their proper  
6 gate in an airport setting, or any other similar situation.

7 Turning to FIG. 1, a simplified exemplary block diagram of a transmitter-receiver  
8 pair 100 consistent with the present invention is illustrated. For clarity, only one  
9 transmitter-receiver pair 100 is illustrated, but those skilled in the art will recognize that  
10 a plurality of transmitter-receiver pairs or a plurality of transmitters and a matched  
11 receiver, or a plurality of receivers and a matched transmitter, may be utilized in a  
12 system consistent with the present invention. The transmitter 102 may be affixed to an  
13 identification band, e.g. an anklet, which in turn may be affixed to an infant. The infant,  
14 and hence the transmitter 102 are typically mobile as the infant is moved about in a  
15 hospital setting. Advantageously, a receiver 104, on the other hand, may be fixed to a  
16 predetermined location near a mother's room, e.g. adjacent the door frame, or carried  
17 on the mother's identification band. Those skilled in the art will also recognize that the  
18 transmitter and receiver may be reversed so that the receiver is coupled to the infant  
19 and the transmitter is fixed to a predetermined location or on the mother's identification  
20 band.

1 As will later be more fully described, each transmitter 102 may be configured to  
2 transmit a separate identification code. Each receiver 104 may be programmed to  
3 respond positively to one identification code at a time that matches an associated  
4 transmitter 102 with an associated receiver 104. In such a way, an infant with an  
5 associated transmitter 102 will trigger a positive match indication from only one  
6 associated receiver 104 that is located nearby the appropriate mother. Advantageously,  
7 this provides a method to ensure hospital personnel are matching the appropriate infant  
8 with the appropriate mother.

9 The transmitter 102 may also include an antenna 108 for transmitting radio  
10 waves 106 to the receiver 104. Various commercially available power sources and  
11 internal transmitter circuitry that may be utilized in a transmitter consistent with the  
12 present invention.

13 A receiver 104 consistent with the present invention may be configured to  
14 communicate with a plurality of transmitters 102. Advantageously, communication  
15 may take place via radio waves 106 at a predetermined frequency to permit  
16 communication there between with minimal interference to and from other RF  
17 equipment.

18 The receiver may include an antenna 110, receiver circuitry 112, an indicator 114,  
19 a user interface 122, a controller 120, memory 118, and a power source 116. The  
20 antenna 110 receives radio waves 106 transmitted by a plurality of transmitters. The  
21 user interface 122 indicates to users various conditions of the receiver such as a match

1 with a particular transmitter, no match, or whether the receiver is functioning properly.

2 A user interface may include visual displays such as detailed in FIG. 2 or any other  
3 indicating means such as audio signals. The user interface 122 permits a user to input  
4 data to the receiver such as programming the receiver to store a certain reference code.

5 The controller 120 controls operation of all the various receiver components. The  
6 memory 118, e.g., EEPROM, may be utilized to store various data, such as a respective  
7 reference code pertaining to a particular mother located in a room next to the receiver.  
8 The power source 116 may be a stand-alone external central power source that provides  
9 power to a plurality of receivers, an internal stand-alone power source, e.g. a battery, or  
10 the power source may be obtained from hard wiring the receiver 104 to the building's  
11 existing electrical distribution system. Finally, the power source 116 may also be  
12 obtained from any combination of the above.

13 In one exemplary central power source embodiment, a central power source, e.g.,  
14 a battery, provides power supply voltage ranging from 7.5 volts to 15 volts DC to  
15 approximately twenty receivers. Given the supply voltage and capacity of the power  
16 source, a maximum wire length of 450 feet end to end of 20 AWG stranded shielded  
17 two-conductor wire may be utilized. Of course, the maximum number of receivers per  
18 central power source and corresponding wire lengths and sizes will depend on the  
19 particulars of the chosen central power source and expected voltage drops between the  
20 power source and associated receivers.

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1 Turning to FIG. 2, an exemplary user interface and indicator on an exemplary  
2 receiver 104 is illustrated. Of course, a variety of user interfaces and indicators that may  
3 be utilized without departing from the scope of the present invention. In addition,  
4 such user interface and indicators may be located remotely from the receiver 104. The  
5 exemplary indicator 114 includes a "Match" display 202, a "No Match" display 204, and  
6 a "Signal" display 206.

7 The "Signal" display 206 may flash intermittently when the receiver is sampling  
8 a signal from a transmitter. Once the signal is sampled, the controller 120 may decide if  
9 the received identification code matches the stored reference code in memory 118. The  
10 controller 120 will trigger illumination of the "Match" display 202 for a predetermined  
11 time if a positive response or match is detected. Alternatively, the controller 120 will  
12 trigger illumination of the "No Match" display 204 for a predetermined time if a  
13 negative response or no match is detected. In addition, the indicator may be configured  
14 to indicate via a flashing "Match" display that the receiver is operating properly, e.g.,  
15 the power source 116 is adequate and the controller 120 is operational.

16 The user interface 122 may include program switches 203, 205 to program the  
17 receiver to store in memory 118 the identification code from an associated transmitter  
18 within range of the receiver. In this instance, a transmitter is first brought within range  
19 of the receiver, wherein a no match signal should initially be triggered. The two  
program switches 203, 205 are then pressed and held. After a predetermined time, e.g.  
three seconds, the receiver unit will attempt to read the transmitter code. The receiver



1 may also read the transmitter identification code multiple times. During this time a  
2 programming mode display may be activated. This may include the "Match" 202 and  
3 the "No Match" display 204 flashing alternately until an identification code is  
4 successfully read or until a certain amount of time, e.g. 12 seconds, has elapsed.

5       Upon successful programming a "Match" display 202 may be indicated. If  
6 programming is not successful in twelve seconds the receiver unit may time-out and  
7 return to its normal operation mode. Programming may then be re-attempted after  
8 releasing the programming switches 203, 205.

9       Turning to FIG. 3, a plan view of an exemplary partial hallway 300 is illustrated.  
10 A plurality of receivers consistent with the present invention 104-1, 104-2, 104-3, 104-n  
11 may be located outside a plurality of doors 302-1, 302-2, 302-3, 302-n. The receivers may  
12 be affixed to walls 304, 306. Given a standard hospital bassinet height of approximately  
13 3.5 feet, the receivers 104-1, 104-2, 104-3, 104-n should be located at a corresponding  
14 height for best communication.

15       Other factors such as interfering equipment, physical limitations, and user  
16 convenience will also dictate optimal mounting height considerations.

17 Advantageously, the exterior location of the receivers relative to respective hospital  
18 rooms in the exemplary mounting locations of FIG. 3 enables hospital personnel to  
19 verify an infant match with a mother before entering the room. In other words, an  
20 infant on an infant bassinet 308 having a transmitter 102 coupled to the infant located

1 within range of the proper associated receiver will trigger the receiver to display a  
2 confirming "Match" display 202 signal.

3 Turning to FIG. 4, an alternate exemplary receiver location scheme that locates  
4 the receiver 104 inside a hospital room 400 is illustrated. The receiver may be located in  
5 position A or position B in an interior corner of a room if only one mother is typically in  
6 such room. If two or more mothers are in a single room, an associated number of  
7 receivers may be placed on an interior wall corresponding to each mother's bed in that  
8 room, or on the mother's identification band.

9 The receiver may be mounted at a height to match the height of a standard infant  
10 bassinet or approximately 3.5 feet. To ensure that the infant, and thereby the  
11 transmitter 102, is positioned close enough to the receiver to allow proper  
12 communication of the identification code, a decal 406 or marking may be disposed on  
13 the floor just inside the door 402 a suitable range from the receiver 104. In an exemplary  
14 10' x 12' room, the decal 406 may be affixed to the floor two feet from a sidewall as  
15 measured at a right angle from the sidewall.

16 An infant with an associated transmitter 102 may be held stationary or may be  
17 moving relative to a receiver 104. The infant may be positioned in any variety of  
18 positions relative to the receiver as long as he is positioned within range of the  
19 transmitter-receiver pair. Reliable communication may occur at a variety of transmitter-  
20 receiver distances, e.g. by adjusting transmitter and receiver power levels, depending  
21 on the particular characteristics of an installation.

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1       The controller 120 may control operation of an apparatus and system consistent  
2 with the present invention. The controller may be programmed to function in a manner  
3 consistent with the flow chart shown in FIG. 5. According to the illustrated flow chart,  
4 the system must first initialize 502 certain variables, e.g., display variables, from which  
5 point it proceeds to run the system main routine 504. The first step 506 of the main  
6 routine 504 is to set displays 506. In this set displays 506 step, based on various  
7 instructions received from the system, different display modes are triggered. For  
8 example, a system error message may be triggered if two or more identification codes  
9 are received. A receiver operational message may be triggered if no transmitter is  
10 within receiving range and the receiver is functioning properly. A "Match" display 202  
11 and "No Match" display 204 may be triggered if a transmitter identification code  
12 matches or does not match a reference code stored in the receiver's memory. The  
13 "Match" display may be set to last for a certain amount of time, e.g. 5 seconds, while the  
14 "No Match" display may be set to last for a different amount of time, e.g. 10 seconds. A  
15 programming message display may also be triggered if the unit is being programmed to  
16 store a certain identification code from a certain transmitter. After these displays have  
17 been set, the system determines if data is coming in 508.

18       If there is no incoming data 508, the system continuously loops back to monitor  
19 whether there is any incoming data until a certain time in the timer overflow subroutine  
20 510 is reached. The measured time in such a timer overflow subroutine 510 may be  
21 between approximately 50 ms and 100 ms depending on system characteristics. If this

certain time is reached, the timer is reset 512, and the system loops back to the beginning of the main routine 504. In this way, the main routine will be run each time that the chosen time for the timer overflow subroutine is reached.

If the system determines that data is coming in, it next makes a determination 514 as to whether the data is originating from a transmitter. If the incoming data is not from a transmitter, the system loops back to the timer overflow subroutine 510.

If the incoming data is from a transmitter, the system reads the identification code and compares it to the saved identification code or reference code 516. Once the identification code has been read, the system evaluates the code to determine if it is a default code 518. If the code is a default code, the system loops to the timer overflow subroutine 510. If the code is not a default code, it is determined whether the programming mode is activated 522. In an exemplary embodiment, depressing the programming push buttons 203, 205 for a predetermined time, e.g. three seconds, may activate the programming mode.

If the program mode has been activated, it is determined if an identification code has been received from an associated transmitter 528. In an exemplary embodiment, the identification code may need to be received multiple times, e.g. three times, before an identification code is considered successfully received. Once this occurs, the received identification code is then stored in memory 534 and the system then loops to the timer overflow subroutine 510. If an identification code is not successfully received, the system proceeds directly to the timer overflow subroutine.

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1 If the programming mode has not been activated, the system determines if the  
2 identification code from the transmitter matches the reference code stored in the  
3 receiver's memory 520. If the identification code matches, the match timer is set 532  
4 and then the system loops to the timer overflow subroutine 510. This then triggers a  
5 proper signal to the set display 506 step to provide a match indication. In an exemplary  
6 indicator, a "Match" display 202 may be triggered to remain on for a set amount of  
7 time. An additional step 526 may be utilized which reads the identification code  
8 multiple times, e.g. three times, to provide added reliability.

9 If the identification code does not match the reference code, the mismatch timer  
10 530 is set and again the system loops to the timer overflow subroutine 510. This then  
11 triggers a proper signal to the set display 506 step to provide a no match indication. In  
12 an exemplary indicator, a "No Match" display 204 may be triggered to remain on for a  
13 set amount of time. Similar to the match process, an additional step 524 may be utilized  
14 which reads the identification code multiple times, e.g. two times, to provide added  
15 reliability.

16 The operation of the present invention depends upon the determination of a  
17 match between a transmitter identification code and a receiver. Preferably the receiver  
18 units are programmable, such that any receiver can be programmed to return a positive  
19 response, signaling a match, to any transmitter identification code.

The embodiments that have been described herein, however, are but some of the  
several which utilize this invention and are set forth here by way of illustration but not

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1 of limitation. For example, the identification code may be set by a transmitter affixed to  
2 an identification band on the mother. Thus, if the mother is moved to another hospital  
3 room, the identification code travels with the mother, so that the receiver mounted  
4 adjacent the door to the mother's new room is automatically calibrated with the new  
5 identification code. In yet another embodiment of the invention, the mother wears a  
6 transmitter, while the receiver including associated circuitry and displays are carried on  
7 the band on the infant. And, in the case of multiple births, each infant may be supplied  
8 with a similarly coded transmitter or receiver. Also, the display may be audible as well  
9 as visual, or audible and visual. Also, the invention advantageously may be employed  
10 for ensuring that medicine intended for a particular patient is delivered to the intended  
11 patient, by providing, for example, a receiver on the medicine cup programmed to  
12 respond positively to the identification code on a transmitter on the patient's  
13 identification band. In like manner, the portals to procedure rooms may be provided  
14 with receivers programmed to the identification codes of the several patients scheduled  
15 for procedures in that room that day. Thus, a patient awaiting a CAT scan won't  
16 accidentally be wheeled into an operating room. Yet other embodiments may be made  
17 without departing materially from the spirit and scope of the invention. For example,  
18 goods or cargo being moved could be supplied with transmitters all tuned to a matched  
19 receiver which may be placed adjacent the frame of the door to the van, or adjacent the  
frame of the door of the dwelling or other destination location, and provide an audible  
and/or visual signal in the event a mis-matched item is removed from the van.

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